Global Precipitation Variations and Extremes

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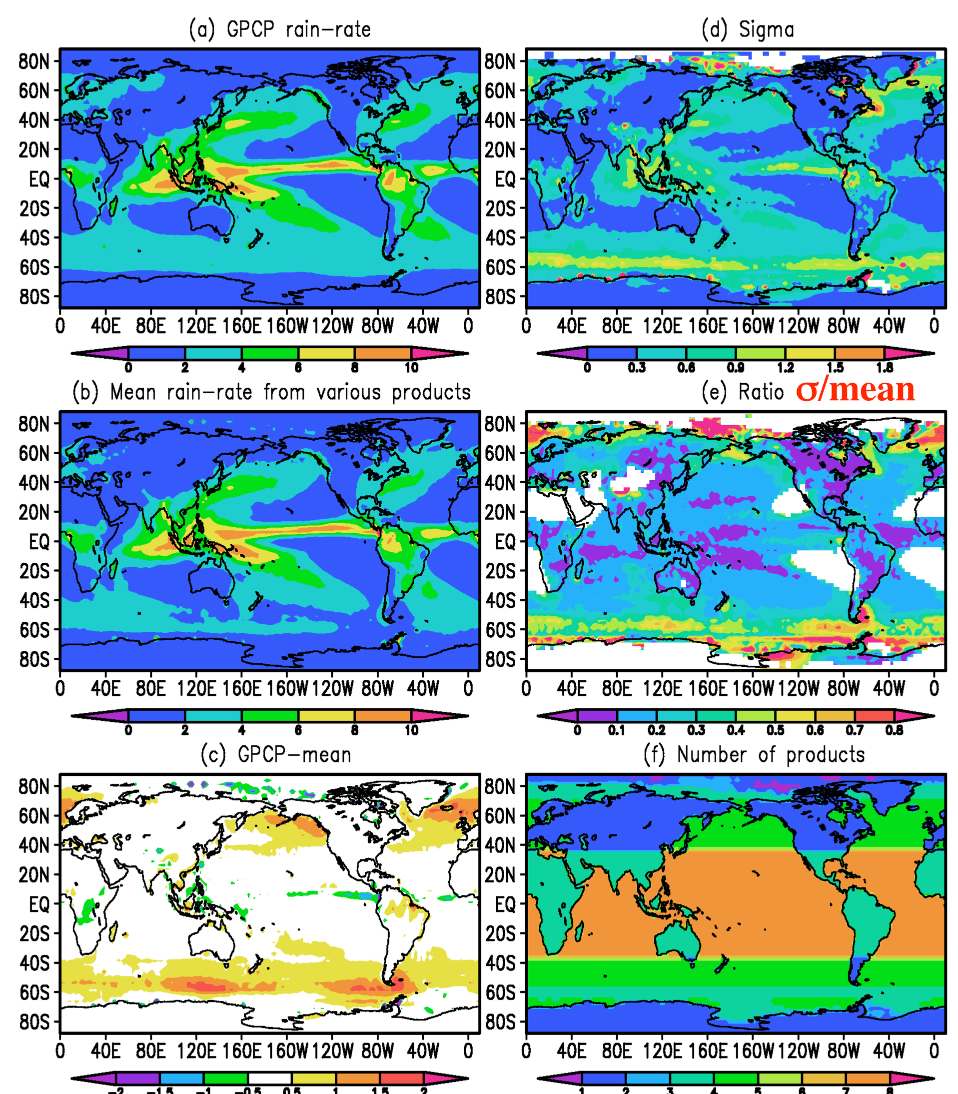
Objectives:

To examine/assess global precipitation variability, extremes and possible relations with surface temperature changes on seasonal-interannual-interdecadal time scales using the more-than-30-year (1979-present) precipitation product from the Global Precipitation Climatology Project (GPCP) and the over-10-year (1998-present) TRMM Multi-Satellite Precipitation Analysis Product (TMPA).

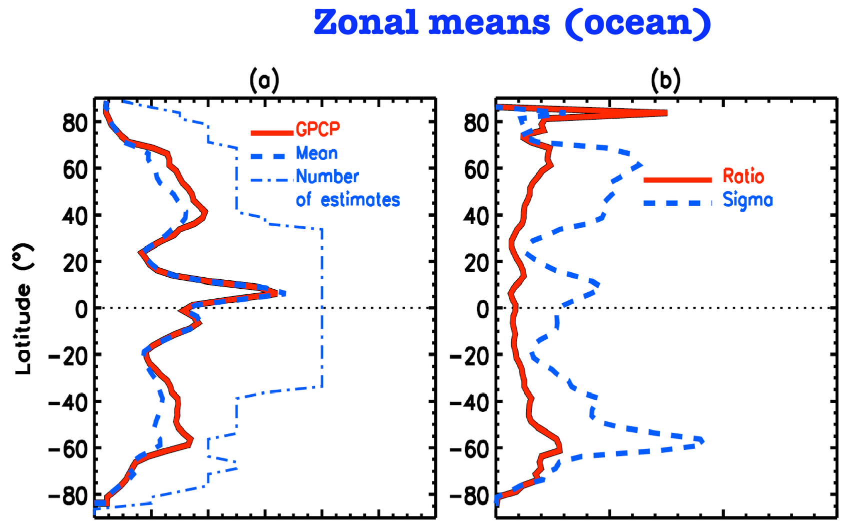
A ten-year (1998-2007) climatology of global precipitation and related bias error estimates



Outline of Method for Global Mean and Bias Error Calculation:

- Potential input products: GPCP, CMAP, GPROF (ocean), RSS (ocean), HOAPS (ocean), TRMM [PMW(ocean), Radar (land & ocean), Combined (land & ocean)];
- Selection of products to be included uses a zonal mean test (land and ocean separate) on individual months;
- *GPCP is used as "first guess"; only products with zonal means (for individual months, ocean and land separately) +/-50% of GPCP are included in the analysis;*
- Composite mean is computed and dispersion of products (equate to bias error estimate) is σ among products; assign to GPCP

Zonal means (ocean)



- GPCP and composite similar in magnitude in deep tropics, GPCP higher in mid-latitude maximum
- σ higher in mid-latitude for same rain rate; *i.e.*, % bias error larger in mid-latitude (~ 15% at 40º vs. ~10% at 0-15º)

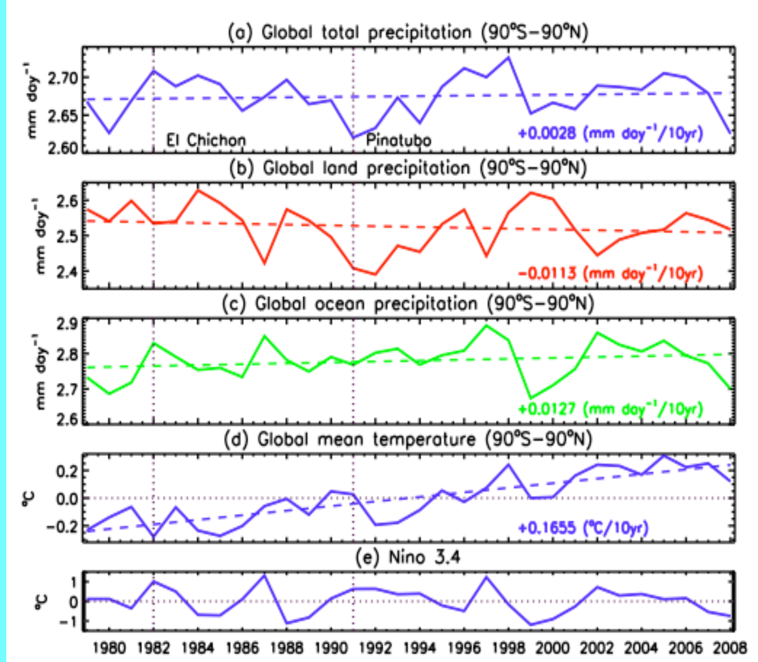
Global (90ºS-90ºN) mean rain rates (mm day^{-1}) and bias (mm day^{-1}) during 1998-2007

- These error estimates may be upper bounds due to regional averaging of errors and inclusion of still questionable input data-sets

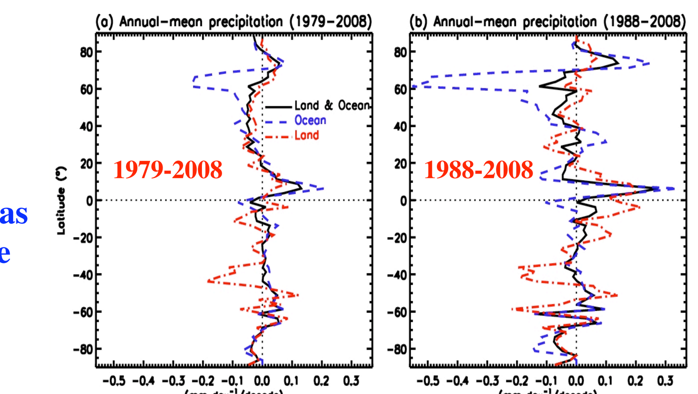
	Rain rate (P)	Adjusted domain-mean bias (σ)	Ratio ($\frac{\sigma}{P}\times 100\%$)
Land & Ocean	2.64 (GPCP) 2.45 (composite)	0.25	9.48%
Land	2.12 (GPCP) 2.03 (composite)	0.16	7.54%
Ocean	2.87 (GPCP) 2.64 (composite)	0.29	10.14%

Interannual-to-interdecadal (long-term) precipitation variability quantified by the monthly GPCP product

Global annual-mean precipitation and surface temperature (NASA/GISS) during 1979-2008



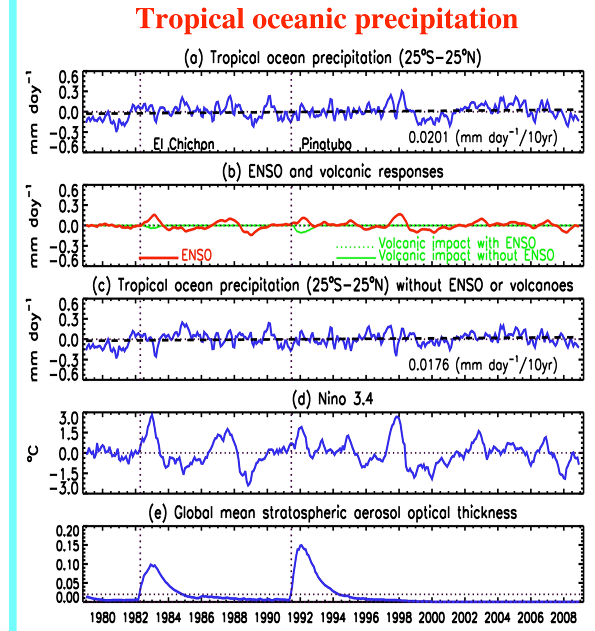
Long-term linear changes in zonal-mean precipitation as function of latitude



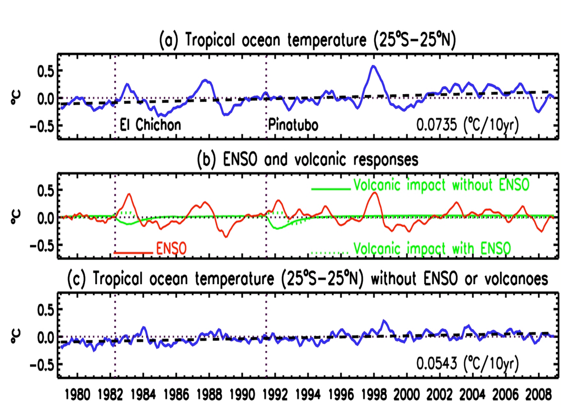
- 2008 near record low global (land + ocean) precipitation; trend very near zero, despite global warming during period; however, large precipitation changes exist within various latitudinal bands, indicating the meridional shift of major precipitation zones;
- Near compensation of ocean and land inter-annual variations leaves slight residual of warmer and wetter years during El Ninos. 2008 was La Nina year;
- Peak temperature in 1998 associated with peak precipitation and El Nino; since '97-'98 surface temperature levels and precipitation varies with ENSO

Interannual variability: ENSO and volcanic impact

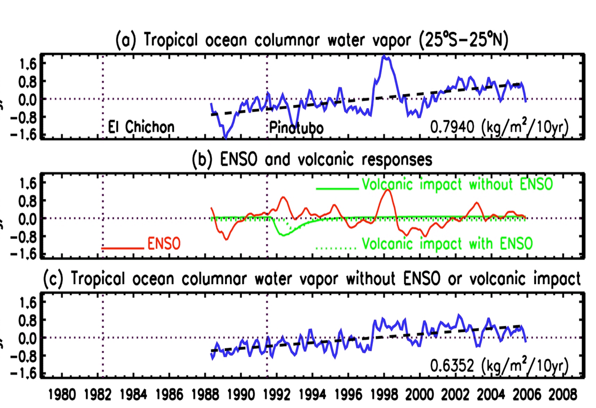
Tropical oceanic precipitation



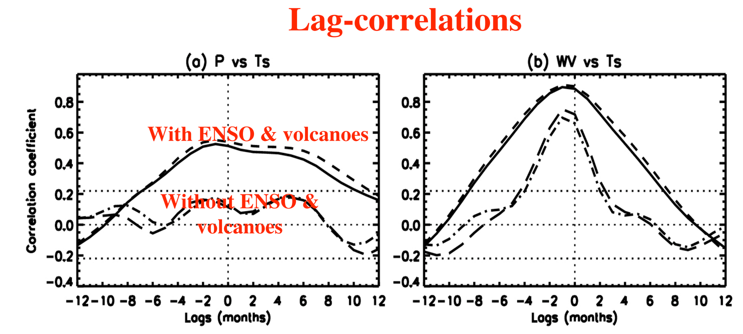
Tropical sea surface temperature



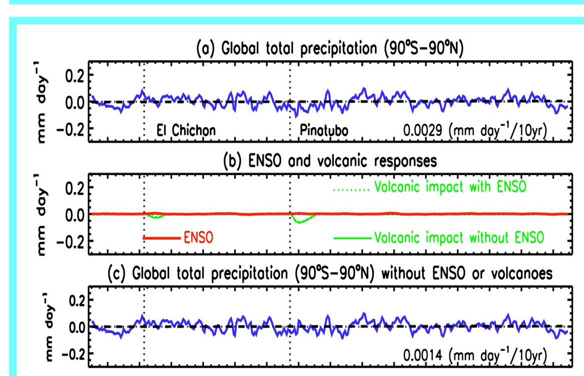
Tropical oceanic columnar water vapor



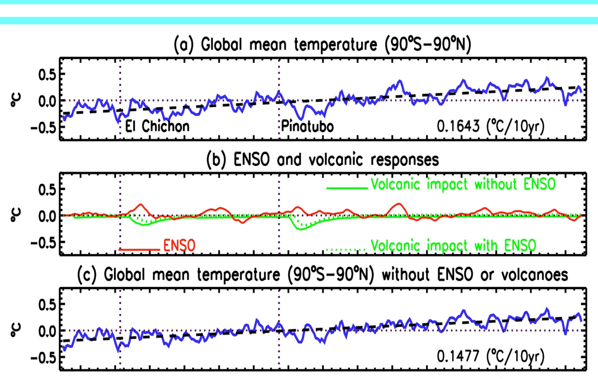
Lag-correlations



- Tropical (land or ocean) precipitation, temperature, and water vapor are strongly modulated by both ENSO and volcanoes;
- *Correlations between (either land or ocean) precipitation and surface temperature are not significant after ENSO and volcanic effects are removed. However, strong correlations between water vapor and temperature do not depend on ENSO or volcanic forcing*



- Global (and tropical) mean (land+ocean) precipitation responds to volcanic eruptions, but seems not to be sensitive to ENSO;
- Global (and tropical) mean (land+ocean) temperature responds to both ENSO and volcanic eruptions



SUMMARY:

- A ten-year climatology of global precipitation is constructed based on the GPCP monthly product. The related bias errors are estimated using the currently-available satellite-based products. These error estimates may provide upper bounds due to regional averaging of errors and inclusion of still questionable data inputs;
- The impact of ENSO and volcanic eruptions during the GPCP record on precipitation are examined. This examination is further extended to the correlation relationships between precipitation and surface temperature specifically on the interannual time scale;
- By means of quasi-global TMPA, precipitation extremes are analyzed for the TRMM period, including both the 11-year means and seasonal means.

References:

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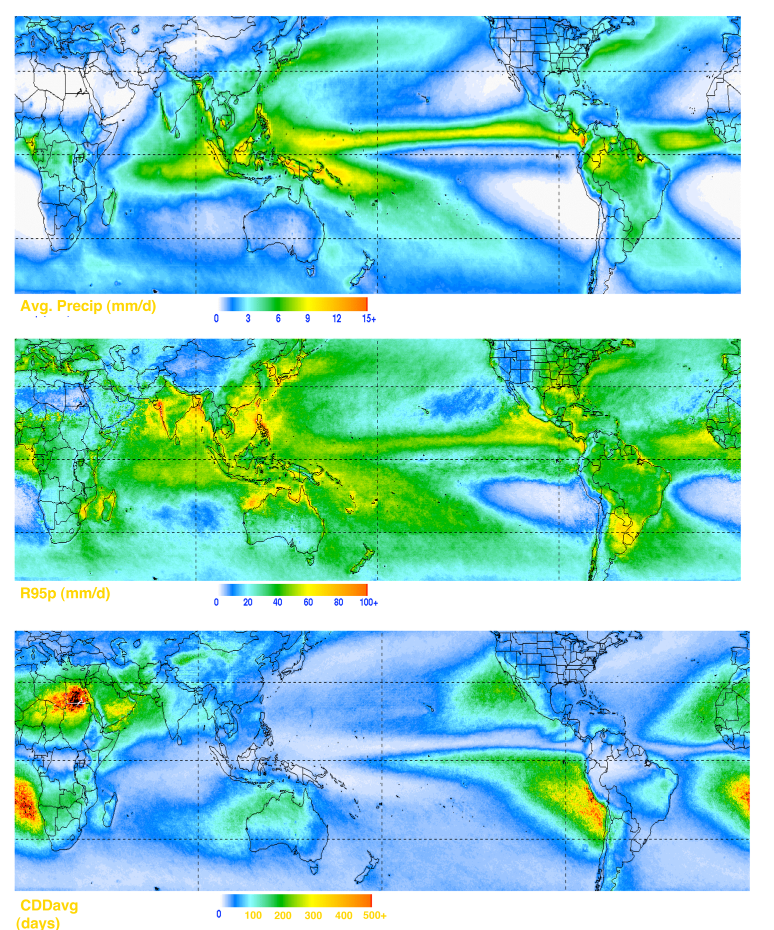
An analysis of precipitation extremes based on the TMPA rain-rates

Indices computed based on TMPA:

- CDD—Maximum length of dry spell (<1 mm/d)
- R95pTOT—Annual total PRCP when RR>R95p
- PRCPTOT—Annual total precipitation

Quasi-global TMPA 1998-2008 "Climatology"



- The Patterns of yearly average precipitation (Avg. Precip) and 95th percentile of daily events (R95p) resemble each other;
- The patterns of Avg. Precip and average longest run of consecutive dry days (<1 mm/d; CDDavg) are nearly inverses;
- In both cases there are some interesting differences.

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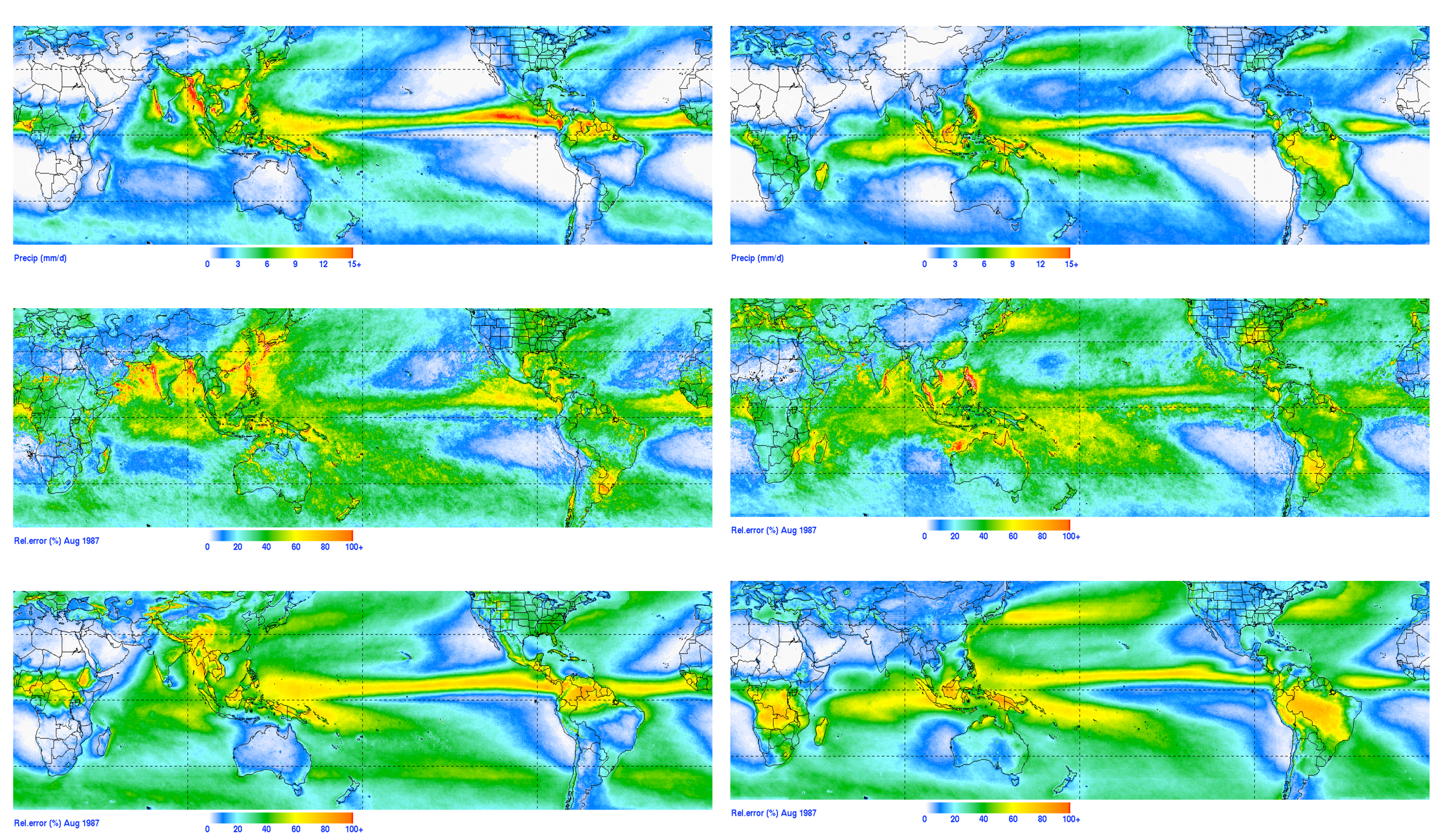
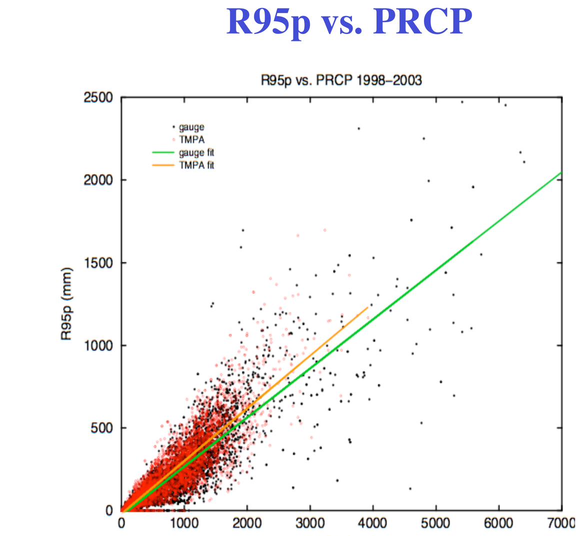


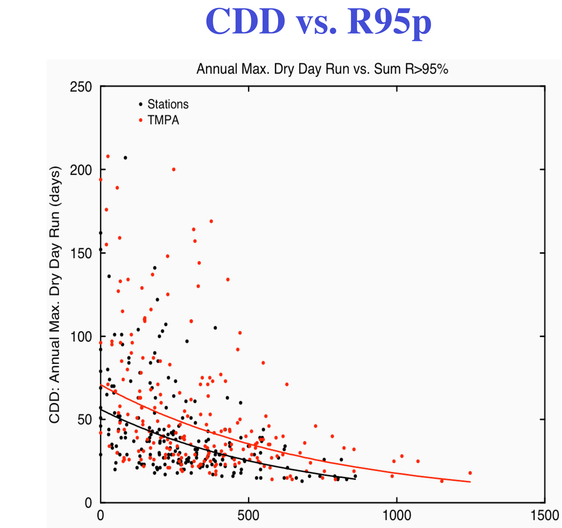
- Regional features tend to be consistent across seasons

R95p vs. PRCP



There is good consistency between TMPA and station data

CDD vs. R95p



- Larger spread at low rain totals likely reflects differences in seasonality;
- Both R95pTOT and CDD tend to be higher for TMPA